DEVELOPMENT OF A COMPUTER BASED MANAGEMENT INFORMATION SYSTEM

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THESIS

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ABSTRACT

Management information is of critical importance in modern decision making. The role of the computer in this process is rapidly expanding, creating challenging goals for data processing specialists and functional area specialists alike. A totally integrated computer based management information system requires long term planning and design effort coupled with detailed analysis of information system requirements. This paper suggests a new relationship between the time value of information and management decision making.

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I. INTRODUCTION

A. NEED

When computer systems became recognized as a definite requirement for the future, there were very few skilled people able to provide the expertise needed to expand with the industry. Consequently many people with varied backgrounds entered the field and obtained formal education in data processing techniques. Others obtained their knowledge by associating with trained personnel or by on the job instruction. Regardless of the avenues leading to the positions of seniority in the data processing field, there still does not exist a generation in top management grounded in the modern techniques of computer science from its elementary levels of education.

Because of the varied backgrounds of all those presently involved in data processing management it is difficult to find a text on the subject of management information systems that appeals to a majority. The success of some of the implemented management information systems has proven, beyond question, the value of these systems and the fact that the designs are more than conceptual possibilities. The success of the information system will contribute greatly to the success of the large organizations of the future.

It is for these reasons that it was determined that a single source was required that would consolidate the total requirements imposed in

the formation, installation and implementation of a computer based management information system.

B. PROBLEM

Managers have historically been promoted based upon their past records of success and discharged because of failure. However, if questioned, even the most successful probably would be hard pressed to explain how he knew when he was making a proper decision. An innate feeling for "the right thing" at times might have been influenced by a severe case of indigestion.

The days of management by intuition are fast fading, if not totally gone, in today's competitive business world. The computer has both assisted and hindered many managers in their quest for success. Those that it helped the most were those that were able to understand the way the computer worked and the new requirements imposed. A problem had to be broken down into infinitesimally small parts each to be able to be resolved on a "go, no-go" decision. Logic had to be examined and tested. Vast quantities of information were made available to assist in making decisions and those that weren't able to use it lost a competitive edge.

The key to managerial success in the present automated environment lies in being able to collect, quantify, retrieve and effectively use the information available in the decision making process.

C. OBJECTIVES

It is the intent of this discourse to approach the topic of decision making by examining the methodology involved so that even the decision maker who is not expert in data processing techniques can better understand the importance of being able to explain how he makes a decision.

It will be shown that through a complete understanding of how an information system works, what its component parts are, and the requirement for involvement by all levels in the design stage, that the manager will be provided with the means to make more effective decisions.

A discussion of the stages of building a management information system should provide a reference or guide for those who are presently involved or who will be involved in future information system development.

In general, by explaining automated systems requirements in terms of well-grounded and accepted management principles and explaining the basic relationships, a method should evolve for the executive to become more at ease and familiar with computerized information systems.

II. THEORY

A. DECISION MAKING

Information processing is a fundamental activity of management. It plays a central role in all phases of managerial behavior, in communication, problem solving, and decision making. The requirements for processing information in modern organizations stem from several sources: the external environment, such as legal systems, customers and suppliers, routine operating activities and management decision and control. Increasingly, over the last ten years, information processing support for management decision and control functions has become the primary concern for those involved in data processing and data base design.

Decision making is the primary management prerogative of the management functions. Certain common characteristics of decision making entail:

1. A compulsion.
2. Comprehension of the situation.
3. Consideration of all relevant factors.
4. Confirmation of objective.
5. Choice of alternative.
6. Communication of the choice.
7. Consequences of the choice. [1]

This subdivision of decision making elements serves several purposes. It affords a basis for distinguishing the line and staff aspects of the process. It is also a basis for determining the utility of electro-mechanical equipment and electronic computers as accessory tools to the decision making process. Finally, it serves to emphasize the distinction between data processing as an administrative supporting service, and sophisticated information systems, as the indispensable modern servant of top management.

In reflection on the seven characteristics of the decision making process, the three middle elements are particularly significant. Consideration, confirmation, and choice have traditionally been conceived of as secret processes that occur internally in the mind of managers.

B. ROLE OF THE COMPUTER

Management can choose to make the decision rules visible. Computers provided the first real capability that could be harnessed with the specific intention of supplementing the mind of management. The computer's ability to swiftly make calculations contributing to comparisons leading toward an optimal solution is unique.

The computer can be an effective adjunct to management's decision making, however, only if the manager provides effective guidance for programming. This includes the ranking of objectives and sub-objectives, the identification of fixed factors and variables,

and some quantified ranking of all relevant decision factors. The manager in effect thus injects the answer into the computer, but as though it were in code. The computer interprets it. Without the benefit of management's objectives and constraints the computer could grind away at raw data forever without arriving at an intelligible conclusion.

C. INFORMATION SYSTEMS IN GENERAL

All functions of management are essentially mental, not physical, with the possible exception of the action step. A primary objective of management is to organize a complex of individuals to perform these functions. These individuals will have intelligence, knowledge, and creative imagination and will be able to add to this knowledge without outside stimulation. However, the total knowledge required to manage adequately, exceeds this.

In any large and complex enterprise, management's collective brain must be supplemented. No man can acquire all the necessary experience or knowledge to manage most effectively. Moreoever, management seldom sees or touches the resources being managed. Thus this collectively organized group needs a management information system to serve every step of the management cycle at all organizational levels.

D. TYPES OF INFORMATION SYSTEMS

There is not one specific system envisioned when the general term of Management Information System is mentioned. Today many people have their own definitions. Following are brief descriptions of four basic types.

1. Formal/automated.

This type of information system is always the most sophisticated, where the machine is more the worker and the man more the designer, director, observer, or user. Electronic computers with all of the associated hardware to complement and connect them are involved in a full blown automatic data processing system.

2. Formal/non-automated.

This system includes all those conventions, procedures, media, that are formally prescribed, legally required, or by habit adhered to; but which are implemented either manually or with minor equipment. The predominant effort is clerical.

3. Informal/formal.

This system could well be a more powerful informational system in the key management sphere than any other output of any part of the entire management information system. This is the product of organized advisory staff work; the formal staff meeting where problems are discussed; the work of formally chartered groups such as a board of directors.

4. Informal/informal.

A system of this sort can be information passed at a cocktail party, a network of personal letters, the grapevine, or any other system of information exchange. This is included because to some extent it does carry information and influence management decisions.

As dissimilar as these four systems might be, they have as a common bond four types of management information or intelligence requirements:

1. Operating document data - This is the most menial but important type of information which must be supplied by a management information system. It is administrative in nature, and without it audit trails would disappear, and general chaos might ensue.

2. Resources or inventory data - This pertains to the resources as of a given date. It also relates to inventory allowances, authorizations or allocations, budgets and accounts. Along with any inventory of requirements, information has to be available on the resources which may be used to achieve the objective.

3. Progress and performance appraisal data - Appraisal information includes ratios, variances, trends and the like, so that management can make sensible and

timely adjustments to programs, allocations, and schedules, to find more rational selections of alternative actions.

4. Decision making data - This comprises futuristic data. Objectives formulation and clarification, board strategy, limits and latitudes of risk, all feasible alternatives and implications of each alternative, probable consequences, etc. It is fundamentally that information which top management wants, needs and uses. It is directly proportional to top management's previously accumulated relevant knowledge. The real management significance of this information is essentially a function of top management's ultimate acting responsibilities.

E. AN INTEGRATED SYSTEM

An integrated information system is one in which all data will enter the system only once, in a universally accepted standard coding and simultaneously with its creation. The same data elements will be in no more different places in the system than vulnerability and relative economy of communications make desirable.

The advantages of such a system are many. It provides the means for specific information being taken care of immediately. It can be made to constantly compare goals to actuality, and have

automatic output of either a mechanical control decision or an exception requiring attention. It could also provide all significant ramifications of possible intentions entered as a query to the system. Finally, the system could include the means to receive a given set of requirements and quickly produce optimal plans from various parameters to obtain desired results; it could maximize (and/or minimize) whatever the interrogator desires. All this is envisioned on a real time basis and with almost instantaneous and intelligible visual display of status or action required. Such a system should be the only legitimate goal for a truly worthwhile management endeavor involving substantial investment in sophisticated computers.

While many agree that this is the goal, not everyone agrees on the method to achieve it. On one hand, some believe that the proper approach is to start at the bottom and work up. A process of integrating by stages at each management echelon until complete integration finally materializes at the apex of the organizational pyramid.

Conversely, others say that the best way to ensure the ultimate integration is to provide for highest management level leadership of the program. Only in this way can the inevitable prediliction for provincialism be precluded. After all, only the manager can input the proper sense of direction, and provide the unified overall purpose that transcends the specific functional areas. (or so the proponents say)

So it appears that the two most popular approaches are in opposition. The two methods are not incompatible and are equally vital to success. The real distinction to be made is not with respect to the relative level of their point of origin, but to their essential purposes, which are quite different. As will be pointed out in the ensuing text, the value of information in the decision making process might also have an impact on the shape of future organizations.

F. BRIDGING THE MANAGEMENT GAP

Top management's job is to specify goals, establish standards, and identify ultimate management information needs. Concurrently, appropriate subordinate levels of line management survey available data in relation to specified information needs, commencing at the very source of such data, and thus proceed to design a responsive system. At this point the evident need for a coordinating staff in the management information system development clearly emerges.

The major objective of this staff is to relieve and serve top management in bridging the gap between top level planning and subordinate level design.

The development of a management information system (referred to hereafter as MIS) can only proceed by rather clear cut stages. Specifically, system design control can be expected to gravitate in due course from the field activity level, to the departmental level,

to the headquarters level. This progressive escalation upward is considered the key to the successful integration of all subordinate information systems.

Whereas centralized leadership throughout the first stages may be characterized by coordinative influences and the provision of only broad policy and general guidance, it must be replaced by more stringent controls for information system design at the outset of the final stage.

III. SYSTEM DEVELOPMENT

A. THE ROLE OF MANAGEMENT

Management's role is to provide a product or service of value to society in return for a profit. The manager, in order to attain that goal works in an environment of competition for profit. Competitive strategies are constantly changing because of the changes in the demands of society and rapid technological advances. With such a state of flux, the process of management becomes a large feedback control device. Even in military management where the "profit" motive is not the technical goal, first an objective is set, or some future condition of the organization which is desired by management is established, and the means by which this objective is to be obtained is determined. To facilitate the determination, such a device is evolved; a device which gathers and reports necessary information relative to the progress the organization is making in achieving its objectives. Normally, the device provides information as to why an established schedule is not being met.

What is within the realm of information that might be desired? As Edward D. Dwyer put it, "Information is management information only to the extent to which the management needs or wants it; and it is

significant to him only in terms of its relation to his accumulation of relevant knowledge and plans and to his personal responsibility."[1]

B. INFORMATION REQUIREMENTS

What type of information must such a system provide? First, there must be information which measures and describes objects and actions in adequate detail for effective planning, action, review, and control at all levels within the organization. Information relative to fixed plans, programs, resource allocations, schedules and other predictions must also be provided. Information which enables management to make valid calculations and projections relative to future organizational happenings is also necessary. Decision data is the information which management wants, needs, and uses.

C. THE SPECIFIC MIS

Thus far the management environment has been examined and the various possible information requirements have been determined. If no system, or if only an inadequate one exists for providing this information, it should now be obvious that some system such as this must be developed. There are many degrees of sophistication involved. The type and complexity of the system must be determined by the manager or analyst in terms of his own organizational requirements and structure.

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[1] McDonough, Adrian, Information and Management Systems, p. 67, McGraw Hill, 1963.

One definition of a management information system can be found in a statement by Mr. D. Ronald MacKenzie. "Information includes all the data and intelligence that are needed to plan, operate and control an enterprise. The task is then to: design a network of procedures that will process raw data in such a way as to generate the information required for management use, and implement such procedures in actual practice."[2]

The major difficulty with a sweeping statement such as this is the question, "How much is enough?" A definition such as this would give a manager, "all the information he requires" without regard for limits on what is reasonable and prudent. No manager can possibly evaluate the entirety of information available prior to making a single decision.

There are four basic goals of management information systems. The first is to deliver information when and where it is needed and to do it in a timely and accurate manner. The second is to filter the distribution of the information. The third is that the system should be able to readily assemble information for special reports. The fourth and final goal is that the system should execute, through its internal log, as many controls as are feasible. This will enable management to control by making decisions about exceptions rather than by every incident.

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[2]Anderson, McDonald W., "The What and Whereto ... Management Information Systems" Data Processing Yearbook, p. 105, 1964.

Once a system designer has accepted the commitment of developing a management information system he must be willing to commit his own time and interest towards the understanding of the detailed plans, techniques, equipment and personnel associated with the proposed system. A major system design effort requires a corps of experienced systems personnel. Management must be willing to acquire these personnel and provide the necessary training to enable them to perform their jobs.

Finally, full support must be given to the systems design team because it will enable them to solicit assistance from any segment within the organization.

D. PRE-PLANNING PHASE

The first stage is to define the problem that you have to solve, in clear and succinct terms. Mr. John Diebold is quoted as saying, "Sometimes what we believe to be our problems are in reality symptoms, the true problem lying far deeper. It is important that we do not try to automate in order to tackle symptoms. A thorough systems analysis and careful thinking through of objectives is the best way of defining the true problem. At the same time an adequate system's study can save management from the opposite, but equally serious mistake of trying to make too fundamental a change in one pass."[3]

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[3]Dickey, E. R., Senensieb, N. L., "A Total Approach to Systems and Data Processing" Total Systems, p. 26, 1965.

What is needed is not providing more volume of data for a business concern, but rather a detailed and penetrating study of the business in its entirety, so that only the information that is truly needed is provided. Production of too much data for management to assimilate is a major fault of many current MIS's. Business must be examined in terms of an overall information system which is, as defined earlier, a composite of inter-related systems and sub-systems which are working toward a common goal. This is the key concept to thorough systems analysis, the integration of the sub-systems. Employing the systems approach, as defined earlier, for solving or defining the problem is not a simple task. It consists of four critical and unique steps.

1. Examination of the problem in terms of its environment.
2. Determination of the users information requirements.
3. Determination of the speed of response requirements.
4. Selection of the optimum combinations of mental efforts, equipment and procedures within the cost restrictions, established for the system. [2]

Upon completion of the preliminary information analysis and actual problem definition, an economic analysis must then be made. It would be very unwise to proceed any further in the systems design without now determining whether the MIS is economically justifiable. The process of economic justification is an extremely complex one.

Basic cost accounting procedures cannot be applied. This is because of the lack of knowledge of the contents of the output of the system in terms of dollar value.

However, we are not left entirely in the cold, for there has been a system proposed for the determination of the economic justification of an MIS. This system is based on efficiency, utilization, availability, and operating speed. The most important and complex of these factors is efficiency. [3]

As defined by Mr. Simon M. Newman, ". . . efficiency is a ratio of the amount of pertinent information produced by the system to the amount of pertinent information which existed in the original documents."[4] The original documents make up the system's data base, and achievement of 100% efficiency would be economically unjustifiable.

Utilization is the ratio of the degree of actual system use to total potential use of the system. Many managers simply do not use the system because they don't know how.

Availability is a measure of the accessibility of the system to its users. Availability is increased by designing the system, both the hardware and the software, with its facilities close to the users. Physical eye appeal must be considered also in relation to this point.

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[4]Newman, S. M., "Economic Justification - Factors Establishing System Costs", Information Retrieval Management, p. 117, 1962.

System operating speed can be called response time, which is defined as the elapsed time from the point where the question enters the system until the answer has been received by the user.

With preliminary systems analysis, problem definition and initial economic considerations completed, alternate solutions will be developed. Consequently, top management must bring the design team up to strength in order to select the best solution and develop a master plan.

E. PRELIMINARY DESIGN

Systems design is the most critical of all phases. A strong information systems design team must be formed and given recognition, responsibility and commensurate authority. Certain key personnel must now be selected and the design team organized. Extreme care must be exercised in the selection because the team will have total responsibility for the entire design and implementation of the MIS, and since their responsibilities are so vital, it is imperative that this be their primary duty. Within this team there must be functional area specialists, systems analysis specialists, and data processing specialists. Without this background of experience, a faulty system may be designed which could eventually prove to be very costly.

The team must approach the problem in a systematic manner. The system designers must first interview all managers and decision makers who will be contributing data or receiving information from

the proposed MIS. They must not ask the manager what additional information he would like on his present reports, but must determine the manager's area of responsibility, what types of decisions he makes, and what information he needs to control his operation and make effective decisions. Guides must be developed in reports which will present only summary information about areas that are running according to plan and more detailed information for those areas deviating from programmed status or progress. They must strive to give the manager only the information he needs to make decisions.

The system design team must then determine the basic types of data to be fed into the system to produce the information required. They must develop procedures for collecting each type of data at its source, automatically if possible, and collect it only once. They must also make sure of the validity and accuracy of the data gathered. Based on the knowledge of the output and input requirements, the systems analysts must design a computer system to collect the required data and produce information as economically as possible. (The distinction is made here between data and information. It will not always be so.)

Inherent within the function of planning is the determination of the feasibility of meeting directed due dates for the successful completion or implementation of the system. The plan must be realistic in terms of its requirements and, it must be consistent with available resources

and time. In developing this plan, the design team must include efforts being accomplished at all levels within the organization. This is necessary in order that the plan provide a coordinated and balanced resource allocation.

The plan must be translated into a schedule. Scheduling must consider the competition for available resources. The process of scheduling must produce a calendar time-phased plan which is consistent with desired completion dates for the assigned system objectives. Once this is accomplished, the schedule becomes the means for authorizing effort and resources to be expended. Additionally, the schedule will serve as a basis for the continuous evaluation of the overall design effort.

In order to evaluate the pogress of the overall system development, management must receive feedback from the designers. It must provide for early detection and specific description of any potentially significant problem areas while there is still time to seek solutions. Therefore a progress reporting system must be established. This reporting system should contain the reasoning which led to the selection of the particular design choice. It should also contain information relative to resources required to accomplish the development and implementation of this design. Each system and sub-system should be described in terms of its functions and how it acts upon, and what it does to the input of the system. The method and means

of developing the sub-systems and their specifications should also be included. In total, the report should leave no doubt that the design selected is the optimal and the most economical.

F. DETAILED DESIGN

During the detailed design phase, the actual accomplishment of final design is performed. This phase is continuous and may last as much as five years, depending on the complexity and scope of the MIS under consideration. Since the results of the detailed design phase take the form of specific system requirements, the progress reporting during this phase should include information relative to the status of the development of the specifications. This should not, however, preclude the reporting of significant problems as they occur in the development of the specification. Depending on the nature of the problem incurred during this phase, the manager may deem necessary that progress reporting occur more frequently than originally anticipated.

G. EQUIPMENT SELECTION AND ACQUISITION

1. Preliminary Facts

A discussion of the advantages of automatic data processing can be found in almost any technical trade journal these days. For purposes of this study, it is proposed to focus on some disadvantages

of data processing equipment to bring into sharper focus some of the reasons why computer procurement is considered so differently by people in different professional areas.

The cost of installing and operating an automatic data processing (ADP) system is of primary importance. A large scale computer may cost about $800,000 just for start-up costs and another $750,000 for annual operating costs. Most usable systems with a central processor and compatible input-output equipment have rentals from $100,000 to $500,000 annually. [4] This represents a very large investment for management and offers only a theoretical prospect of return, and that, only after a considerable number of man-years spent in analysis, planning, coding, conversion and the running of parallel operations. Other difficulties that make computers unique are (1) channeling of work. Since the organization's information has to be fed through one piece of equpment this causes many machine scheduling problems. Some of those problems have been mollified with the techniques of multi-processing and multi-programming as well as timesharing but the directing of the flow still poses a problem. (2) conversion problems. Site preparation costs for power consumption and air conditioning as well as conversion of source documents. (3) training of personnel. Usually not accomplished on the same time schedule as the installation of equipment. (4) organizational problems. Resistance to change.

In summary very few other items that can be purchased have such a far reaching effect and for that reason special techniques were developed to accommodate the computer.

One such technique was the lease versus purchase criteria. No firm policy guidance for the Executive branch of the Government existed until 1961 when the Bureau of the Budget (now Office of Management and Budget) published Circular A-54. [5]

In March of 1963 the Comptroller General sent a report to Congress in which he recommended the establishment of an office in the Executive Branch to make possible Government-wide decisions on the financial advantages of purchasing, and to assure more complete utilization of equipment. Most commercially available ADP equipment can be acquired by purchase or lease, with or without an option to purchase. [6]

2. <u>Lease vs Buy</u>

Section III, part 11 of the Armed Services Procurement Regulation (ASPR) deals directly with the acquisition of automatic data processing equipment. It says that prior to any decision to lease ADP equipment, the contracting officer must conduct a review. Such review to cover, but not be limited to five major points.

(1) Screen Defense Supply Agency (DSA) for any excess government-owned equipment that would satisfy the requirement.

(2) Determine if leasing policy is appropriate and beneficial to the government.

(3) Consider leasing under provisions of the Federal Supply Schedule Contract (ASPR 5-903.1 "contractors shall be authorized to use GSA (General Supply Agency) supply sources ... when the contractor will lease ADPE under Federal Supply Schedule Contract for use only in performance on cost reimbursable contracts.")

(4) Include an option to include maximum rental credits toward a future purchase.

(5) Obtain approval of top policy officials of the respective service requesting the equipment.

This same article further states that if the total annual cost applies to cost reimbursable contracts and the cost is over $500,000 an initial and annual review must be conducted to test the existing ADP capability and to verify the continuing need. Also any major changes to the lease (over $25,000) must have prior review of the Administrative Contracting Officer.

Leasing has been predominant for several reasons. First, the large initial outlay has been one factor. Also, the machines produced by the largest manufacturer could not be purchased for several years after the introduction of ADP equipment on the market.

One of the advantages of renting equipment is that the large expenditure can be spread over several years and not distort the budget for any one year. The increasing technology in the field has rendered past equipment obsolete long before its useful life was expended. Program changes which might decrease computer utilization or eliminate the need for the installation or base, thereby making leasing attractive.

On the other hand, the major objection to leasing is that rental costs may exceed purchase costs if the equipment is leased for eight or more years.

Another report put out by the Office of Management and Budget states, "Although the number of purchased computers has increased in each of the fiscal years reported, the percentage which this number bears to the total number of computers has declined, except for a slight increase in 1963." It further states, "It may be expected that there will be a greater proportion of purchase in the future as an objective consideration of the alternatives is applied to each case."[5] It is interesting to compare the prediction of August, 1962 with the actual results and the figures of the ensuing years. Enclosure (1) shows a predicted rate of 14.7 purchased computers to 85.3% leased with a total of 1169 machines for 1963. This was extrapolating only

[5]Inventory of ADP Equipment in the Federal Government August, 1962, Bureau of the Budget.

one year into the future yet the actual figures show a relationship of 21.3% owned to 78.7% leased and a total of 1326 machines. This indicates that the original estimate was understated by approximately 15%. Additionally, the total number of machines for FY 1971 is 5961 (an 820% growth from 1961) with 72.1% owned and 27.9% leased. A notation to the chart says, "the owned portion of the inventory has reached 72%, reflecting further increases in the special or mini-computers which are generally available only on a purchase basis, and purchased due to their relatively low cost. Another major factor has been the conversion of installed leased equipment to "owned" as a result of the exercise of contractual purchase agreements."

The importance of a standardized procurement policy can be emphasized by showing the distribution of the computers solely in the Department of Defense. Out of a total of 5961 the DOD has close to 60% of the computers. [7]

Air Force.	1271
Navy	1021
Army.	949
DSA	128
OSD	12
Others.	34
	3415

There still remains a tendency, however, to rent and lease computers even when the arithmetic clearly indicates that they should

be purchased. There are several reasons for this rental fixation: (1) the annual budgetary and congressional appropriations system favors the smaller rental figures as against the larger purchase items. (2) Suppliers have been reluctant to sell their equipment. (3) Agencies not technically equipped to manage ADP facilities have preferred to turn most of their computer management over to the suppliers, along with a rental contract. (4) In other cases agencies have feared that a purchase commitment may later prove to be shortsighted in view of the rapidly changing technology [8]

A general feeling about this subject that is shared by many is described as follows: "EQUIPMENT LEASING IS SOMETHING LIKE FREE LOVE . . . BOTH HAVE COST ADVANTAGES OVER OWNERSHIP OR MARRIAGE, BOTH INVOLVE RELATIONSHIPS THAT MAY BE TERMINATED EASILY, BOTH ARE SUBJECT TO LEGAL DIFFICULTIES NOT FOUND IN THE CONVENTIONAL ARRANGEMENT, BOTH ARE PROBABLY MORE TALKED ABOUT THAN PRACTICED." Walter Buckingham

3. <u>Contract Administration</u>

The Comptroller General reports show that overpayments of hundreds of thousands of dollars have been made by agencies because of failure to understand and properly administer contract provisions that are used in determining rental payments. In some instances poor record keeping procedures for recording equipment utilization information had led to overpayment. Recently a

conceptual system has been put forth for proper reporting of ADP equipment and systems.[6] It is intended to include the current characteristics of technology. It is oriented toward the use of equipment and systems more as a government resource than the proprietary utilization within a single department or agency. Through common standards for common equipment, it facilitates sharing of utilization among departments and agencies. The highly complex nature of the technology is recognized and the system includes reporting for equipment managers who need to exchange system enhancements for increased efficiencies and users to compare the economics of using particular equipment configurations.

Contract administration will probably continue to be the subject for general accounting office reports. Management must exert considerable effort to correct the mistakes unearthed by the examinations of previously uneconomical procedures. The following list represents some of the significantly improved items that have been obtained through contract negotiation. [9]

(1) Rental contracts for ADP were placed on a "use" rather than an "availability" basis. Under the former concept no extra shift rental is paid until the equipment is actually used 176 hours per month.

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[6] Ensign, R. B., "A Conceptual System for Reporting Utilization of ADP Resources", (DOD Computer Institute 1972).

(2) Equipment must perform fully and properly at a 90% effectiveness level for 30 days before rental is paid.

(3) Liquidated damages were included for failure to install the equipment by the specified date.

(4) Amount of program testing time was increased.

4. Formation of ADPESO

With regard to the contractual process the need for a centralized control was recognized when the Secretary of the Navy established the Automatic Data Processing Equipment Selection Office (ADPESO) on 1 July 1967. Prior to its establishment there was no common system in use. The selection of ADPE was accomplished by the various heads of departmental components. The procedures used varied depending on the philosophy of the head of each of the departmental components. There was widespread use of AD HOC committees that were formed as the need arose. The contracting was conducted by a regular contracting officer not specifically specialized in the procurement of ADPE.

The establishment of ADPESO thus accomplished two significant advantages. First, the responsibility for selection of ADPE was centralized. Secondly, a full time staff was hired to carry out the mission of ADPESO. In addition to centralizing the function, it was also elevated to a higher level in the Department of

the Navy. ADPESO is presently assigned as a field activity under the command of the Chief of Naval Operations. Thus top management attention is always focused on this vital function.

There are several significant benefits derived from this organization. The most important is that the professional knowledge of each individual presently involved in the selection process is greater now than was the case prior to 1967. This increased knowledge has a profound impact on the Requests for Proposal (RFP) sent to vendors, and the evaluation of proposals submitted by suppliers.

In the prior years, the specifications and RFP's prepared by the user activities tended to be oriented toward a particular manufacturer due to the lack of expertise of the individuals preparing them. User personnel assist ADPESO in the appraisal process of vendor's proposals, but this effort is still under the close control and direction of ADPESO. Within the organization The Source Selection and Evaluation Board is actually responsible for preparation of the RFP and the review of all corresponding proposals. It is important to note that this group is constituted for the entire life of equipment acquisition. This comprehensive understanding of the user requirement coupled with specialized knowledge of the individuals on the SSEB create a climate favorable to rational and objective evaluations.

5. <u>Five Steps in Computer Procurement in ADPESO</u>

(1) System Specifications. A standardized format and extensive review prior to submission to vendors.

It is Navy policy to minimize the number of mandatory requirements contained in each specification. Every item classed as mandatory is carefully reviewed. When justification does not substantiate the claim, the item is reclassified as a desirable feature. This is done so that the specifications will not become so stringent as to either discourage vendor participation or to cause an undue number of proposals to be classified as non-responsive.

(2) Selection Plan. Detailed instructions that are used to evaluate proposals submitted by vendors. This list must be developed prior to issuing an RFP. By doing this, greater objectivity is injected into the evaluation.

(3) Vendor Liaison. Any information provided to one vendor is provided, in writing, to all others. All rules provided to each supplier so he will know what behavior is expected of him.

(4) Validation of Vendor Proposals. Verification of the proposed system capabilities and validation of the system timing. The Navy uses several sources of data to verify the system capabilities. First, the vendors are required to provide technical data in their proposal. Second, ADPESO has manufacturers' technical manuals and the Auerbach Standard EDP

reports. The primary method of evaluating system timing is through benchmark programs where a certain job must terminate at specific points and timing results generated at each position. A more recently accepted method currently in use at ADPESO is the use of computer simulation.[7] Utilization of a mathematical model to create system conditions required. Depending on the type of computer program you are testing, the methods vary. Experience has proved that benchmarks are the most reliable overall.

(5) Evaluation of Vendor Proposals. The method used by the Navy is based on the cost-value technique. Other methods available are the cost-effectiveness, and weighted scoring techniques. The former does not provide for the probability of the workload falling below the projected reference workload line. In the system in use the user indicates a projected rate of growth and then assigns a probability to the levels above and below the trend line. The main advantage when contrasting the Cost-Value, and the Weighted Scoring method systems is that the results are expressed in dollars instead of points. This way

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[7] Joslin, E. O., Computer Selection, Addison Wesley Pub. Co., p. 105, 1968.

management can understand what is happening in the evaluation process, but there is no real need for these people to understand complex and technical data pertaining to each proposal. By using the cost-value system the cost and worth of desirable features can be easily identified, which is very important in view of the recent pricing policies of ADPE manufacturers which will be covered later under the term "unbundling".

Managers who believe their organizations have a proven need for ADPE, but who lack funds either for purchase or lease should investigate the possibility of sharing equipment with other government agencies in the local area or to acquire unused government-owned equipment through the re-utilization program. Utilization figures gathered by the military services and defense agencies indicate that most computers are being used only on a two shift basis. This leaves room for expansion that can be absorbed by any agency in the local area with no equipment of their own. Additionally, the General Services Administration publishes a periodic summary of all government-owned equipment not presently being used that can be acquired for only the cost of packing and transportation. Pertinent directives are DOD INST 4160.19M and SECNAVINST 10462.17.

6. Government Regulations

The importance of proper and efficient procurement policy as it relates to ADPE is exemplified by current regulations. Two items

in this category are, first, the so-called "Brooks Bill" (Public Law 89-306) which has as its purpose, "To provide for the economic and efficient purchase, lease, maintenance, operation and utilization of automatic data processing equipment in Federal Departments and agencies". The second item is a memo from the former Deputy Secretary of Defense, Mr. David Packard, dated 6 February 1970. The subject is the Implementation and Expansion of Automatic Data Systems. A pertinent paragraph states . . . . "further development, implementation or expansion of automatic data systems will not be undertaken until the services and agencies have critically reviewed these systems. Until this review has taken place, no action will be taken toward further acquisition of computers, including issuing an RFP, entering into a contract or otherwise issuing an order for computers, or committing substantial resources toward further development or revision of automated data systems." Pertinent sections such as this appear throughout the document.

These and other articles of legislation led to the major equipment manufacturers breaking down the heretofore "packaged" computer systems. This came to be known as unbundling. What is accomplished was to provide a cost breakdown of all parts of a computer installation proposal. The hardware was priced separately as was the programming, maintenance, peripheral units. It was envisioned that this would allow smaller equipment manufacturers to bid on portions of the total system to diversify the government's

holdings of the major manufacturer. In some cases it did this but a side effect was to result in a higher overall cost of a total system, because major suppliers were forced to raise their prices for portions of a system since their previous pricing policy had been predicated on total system procurement. Additionally, greater time and analysis is required to evaluate the compatibility of different suppliers to the major hardware configuration. Considerations in the procurement process to get the best quality, from the best suppliers, at the best price are best served by centralized procurement when the item purchased is a computer system.

The government is cyclic in its policy toward centralization and de-centralization of various activities. In the light of changing technology or new information from other sources new decisions need to be made. It didn't take long to realize that decentralized procurement policy for computer systems required far more expertise than was available. Established procurement methods and techniques were not satisfactory in view of the large capital expenditures, the rapidly advancing technology, and the long lead time between establishment of specifications and systems delivery.

7. Conclusions

It should be evident at this time to anyone familiar with government procurement policy and regulation, that data processing requirements pose a particularly discrete set of problems. Some of these have been addressed here and others have been referenced.

However, it is only the intent to establish the need for new procedures for new technology not to educate a procurement technician.

In citing ASPR it becomes apparent that more emphasis was given to the leasing arrangements with procurement (outright purchase) policy referred to the top policy official of each service. In the case of the Navy it is the office of ADPESO that is charged with the overall coordination of ADPE requirements.

A major problem that has been at the base of many other related problems is the fact that when one ADP system is replaced, the new system is not compatible with the old one, even if it is from the same manufacturer. Parts of this problem are being faced by the government policy on standardization but that has at least two decades to go before any far-reaching effects can be observed. Another part of this problem stems from the fact that most people are aggressive and want to keep up with the state of the art. The technology of computers is so unlike anything else that this idea is not only impractical, but in some cases foolhardy.

Technology has advanced at a rate far in excess of the progress of the applications for that technology. Even the manufacturers are hard-pressed to get an 85% efficient utilization from some machines. Therefore, when a headquarters hears of a new system on the market and rushes in to buy it, only to have the latest equipment, they are causing chain reactions in inefficiency too numerous to mention here.

H. INSTALLATION AND CONVERSION

Considering that the design has been agreed upon, and the equipment has been ordered, there are still many considerations that require attention before the equipment is delivered and operational. Location of the system is of primary significance, for if it is not located convenient to the user and the operator alike, it will reduce the efficiency of the MIS. This is not to say that the main frame of the computer be located in the middle of a central work area, but rather such things as remote inquiry terminals should be present in major user areas. This type of access gives each user a virtual computer of his own and he feels as though he is the sole user. A consideration that must be reckoned with in relation to user accessibility is that of the funding of the annual expenses. The U. S. Department of Agriculture obtains funds for the operation of its MIS directly from the divisions using its services. Therefore, if a system is not accessible, it is not popular, and if not popular it is unused, and then unfinanced and eventually removed.

Even if a present system exists there is a real need to critically examine the necessity for any major construction requirements. The power consumption may vary from the present system, floor loading capacity may change and air conditioning requirements may be greater. It would be embarrassing to say the least, to be in the position of the agency who went to all the trouble to get the proper power, revamping the air-conditioning ductwork, restructuring the floor in the

installation site, only to find that while transporting their new system from the freight elevator to the installation site, it fell through the floor in the passageway. Additional weight requirements had not been considered.

Another facet in planning for installation is the concept of system security. It is a proven fact that emanations can be picked up and translated by sophisticated apparatus as much as half mile from a data processing site. Cost considerations are a major trade off in this area because the most secure system in use today uses a completely copper shielded room with a double thickness of copper sheeting sandwiching one foot of insulation.

Contingency plans must also be formulated for the event of a total system breakdown. What sort of backup facilities are available? Can they be used during prime shift hours? What type of emergency files exist to be used to reconstruct data if it is lost. These are but a few of the questions that have to be answered. The rest will make themselves evident in the ensuing pages.

Regardless of whatever prior system existed the new MIS will require some type of conversion. Admittedly, the less the better because of the disruptions, but in some cases if there is little conversion required, perhaps the old system is not being supplanted but merely speeded up. There are three fundamental types of conversion:

1. manual to automated

2. old computer to newer model

3. old computer to new manufacturer.

In each case there are specific problems uncommon to the other cases. A conversion team should be established with membership from each of the functional areas supported, as well as an expert staff of data processing personnel. This team should have a detailed knowledge of the current systems' requirements and objectives in order to restate them in terms of the replacement system. They should also set up test routines which can be used to prove the accuracy of the new system in terms of the old, and vice versa. After these test results have been evaluated and before the old system is abandoned in favor of the new, a parallel operation can be conducted using real data (as opposed to test data) to assure the compatibility of results. This should be done only if it can be accurately determined that there is a requirement for it, since the cost considerations of running both systems simultaneously are excessively high.

I. TEST AND EVALUATION

Once the new system is in operation, the test and evaluation phase begins. This should be a continuing effort which seeks to take advantage of any new developments as they occur. The quest for determining information needs must be continued indefinitely. As personnel within the organization become more familiar with the new

MIS and its capabilities, they will produce new ideas for extending and modifying the system output. These ideas must be evaluated and, where economical and feasible, be implemented. Since by this time the design personnel will have acquired a great deal of experience and, if the system was designed to be flexible, changes and improvements to the system should be easy to accomplish.

During the evaluation process, a determination should be made as to whether or not the MIS as designed actually fulfills its objectives; the primary one to provide management with only the required information.

The faults encountered in many of the computer based management information systems of today result from hasty, inadequate and improper systems analysis and design effort before actual programming of the system was started and inadequate follow-up after the system was implemented. One of the paramount faults of information systems is that they present management with "data" not "information". (Here a gross distinction is made between data and information which was not made throughout) Many users of information systems, and unfortunately many systems analysts, are familiar with the historical way data has been collected and reports processed using punched card equipment. Many of these ideas and attitudes from punched card systems have been transferred to the design, development, and use of present computer systems. They result in the design of a system based on a series of simple data-handling steps of the kind which

can be carried out by the punched card process with a computer being substituted for the electric accounting machine (EAM) instead of being used to capacity.

This type of system completely fails to make use of most of the advantages of a computer and ignores the new techniques of data handling, evaluation and presentation that have been developed since the advent of the computer. If an information system design for a computer looks the same for punched card operation, the probability is extremely high that the system, although designed for the computer, makes poor use of the computer capabilities. It most likely costs more than it should, and most important, it produces "data" instead of "information".

IV. THE VALUE OF DATA/INFORMATION

A. INTRODUCTION

It has just been shown that the presence of two existing concepts within a system can exist; data and information. If the system receives data and has data as its output, it is not considered very efficient. If it has data as an input and information as an output, it is acceptable. However, a third situation exists wherein a system might accept raw information as an input and output more precise information.

An integrated system has been discussed from two sides; those that believe it should start at the bottom of the managerial pyramid and work up, and those that think it should start at the apex of the triangle and work down. It will be proposed here that there are other alternatives that might be considered as the possible shape for a future organization. An integrated concept is that time is of basic importance in the decision making process because of its impact on the value of information.

B. BACKGROUND

In the late 1950's and early 1960's a flurry of articles appeared forecasting radical changes in the management structures of organizations by the 1980's. Most students of management generally believe

and accept the hypothesis that both management concepts and organizational structures are in a constant state of transition or evolution. Since it is now almost the midway point between the forecasts and the time of realization, it might be proper to assess just what is going on.

The prediction of the state of management and the organizational structures of the 1980's were widely varied and often in complete opposition. [10] Figure 1 Appendix A shows the range of the predictions. The traditional pyramidal organizational structure stands in the middle; on either side are the extreme views. One forecast was that the organization will evolve to the hourglass structure depicted on the right. The bulging pyramid on the left shows the other extreme. Here we find an increase in the levels of management, a relative increase in the number of middle managers, and a relative increase in the number of skilled versus unskilled workers. In the former "hourglass" structure there would be fewer levels of management, an increase in the number of top managers, a decrease in the number of middle management and a relative increase in the number of skilled versus unskilled workers.

In addition to these extreme views there is also a group who believe that the traditional pyramid structure will not change, with the exception of an increase in the number of skilled versus unskilled workers. That seems to be the only general point of agreement. Which then, becomes the proper shape to expect? The arguments

for each side show that there will be no easy answer to the question. The only answer it seems, lies mainly in the process of interpretation. This is particularly true when it comes to interpreting the role that the computer and quantitative analysis will play in the future.

The best arguments for the hourglass structure are represented by Simon, Leavitt and Whistler. [11] The preponderance of arguments revolve around three main predictions.

1. The increasing use of the computer will force a regrouping of activities in the various functional divisions and at various levels of the organization.
2. The computer will be used to process and make more and more of the routine management decisions.
3. A shift to top management of a larger proportion of innovating, planning, and creative functions with concomitant centralization of the decision making process.

Mr. Simon has made one very interesting point when he said that the effect of automation may take place in some rather surprising areas. He noted that the work of some people is much easier to automate than others. Thus, those that think that they are immune to auto mation because they are designers, and "thinkers", may receive quite a shock.

Those who predict the bulging pyramid structure, do so, primarily on two bases. First, they base their forecasts on an extrapolation of the past. With the increased size and complexity of organizations,

the tendency in the past has been to increase the size of staffs and all present levels of management, while also adding new levels of management. These forecasts tend to believe, "that some managers would rather live with a problem they can't solve than use a solution they don't understand."[8] Secondly, Mr. Anshen and others of his school believe that computers will be limited to repetitive decisions based on already quantified records of costs or data. [12] This will leave, relatively untouched, such managerial decisions as funding problems, setting objectives, implementing decisions, and evaluating results, all of which require a great deal of management information and creative thinking.

More recently Chris Argyris has argued very persuasively that the psychological impact of management information systems upon managers is such that they will never accept the situation forecast by Simon and his cohorts. [13] He further argues that management science/operations research personnel are unprepared to deal with the behavioral aspects needed to gain widespread acceptance of their ideas.

Studies have proved that both the hourglass and bulging pyramid are possible. Ida Hoos has found in her study of nineteen business organizations that computer applications had radically changed the

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[8] Radar, Louis T., "Will Management be Automated by 1975?" Management Science, Vol. 14, July 1968.

organizational structure and the decision making process. [14] She found that as more and more operations were programmed in the data processing department, the functions of operating departments were often undercut and truncated. This resulted in both a compression of the number and levels of middle managers, while the power and status of the new computer group grew.

Facts that would seem to disprove these points, such as those proposed by Shaul and Jones, show that, ". . . the prophesised demise of the middle manager, like the reported death of Mark Twain, 'had been greatly exaggerated.'."[9] In brief, these studies have not borne out the more radical positions. They do show that there has been a shift in the amount of time middle managers spend on individual functions. They now do less controlling and more planning, staffing and directing. More time is available for motivating, leading and training (functions the computer cannot do).

In order to perform any meaningful trend analysis, it is necessary to look at the current trends of some of the factors which will undoubtedly have an influence.

The changing age profile and general educational level increase of the American working force should have several effects. First, there will be a large influx of young, more highly educated workers

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[9]Shaul, D. R., "What's Really Ahead for Middle Management" Personnel Magazine, Nov.-Dec., 1964.

throughout the organization. This will have several effects, perhaps the most significant of which will be those due to the greater flexibility and desire for change inherent in the young. This will be reflected in pressures for greater automation, since the young, more highly educated worker shuns the repetitive, undemanding work. Probably it will also result in less support for unionism, since the young have little vested interest in security.

Another effect of the changing age profile will be the significant decrease in the number of available middle-aged managers, resulting from the decline in the birth rate during the depression years. Middle management will be composed of younger, better educated but less experienced personnel. This lack of experience will probably be reflected in building more checks and balances into the control system.

The influence of greater education is probably the single most important factor, since the trend of many other factors (such as future uses of the computer) flow directly from it. Even among the most disadvantaged, the average educational level is going up about two years per generation.

These trends lead to a consideration of what effects the computer will have. There is general agreement that the computers, with their vast capacity to store and manipulate management information will affect the process of managerial decision making. There is less

argument on the scope of the computer's potential in automating decisions, and on the vulnerability of middle management to displacement by computer programs.

Although the computer can be used as a tool to allow middle management to make better decisions, it will only free the man to make other progress in the management field.

C. RELATIONSHIPS BETWEEN INFORMATION AND MANAGEMENT

Management is the exercise of control through decision making. Decision making is a result of information correlation. The process includes assumptions to complete a picture formed by incomplete information, then intuition. This requires an expenditure of management energy with time as a limiting factor. Thus, information and time are the utilities of management. Increasing quantities of information requires increasing quantities of time for correlation, or an increase of energy expended in the correlation. The qualitative difference among management rests in the manner in which they use their utilities. Martin Ernst has described the current situation: ". . . we face the fact that management itself will become more vulnerable in its decision making. As business uses more complex decision making tools, and as it relies more heavily on large data banks, there will be more filtering of information by management staffs before materials for decisions are presented to the senior management. Even today, a large fraction of the decisions of senior

managers are not made by them. They are forced on them by the selectivity of their staffs in providing data and in presenting arguments. As the staffs grow bigger and the data base more complex, the filtering mechanism will expand and senior managers will find it more difficult to exercise personal control."[10]

The complexity of management often causes decisions to be made based on personal confidences rather than upon information processed. This form of decision making has led to the myth of management information systems and the reality of "group decision making". Such informal management introduces parallel, and often conflicting information systems.

The process of management has been shielded from true evaluation by the accepted mystique of decision making and the security offered by illusive information systems. Typically, management has been viewed as a formal structure of decision points rather than an interpersonal flow of information where the exercise of control is an evolutionary process. Coordination and concurrence represent a great number of such repetitive and routine decisions. These types of decisions should be identified so that the information flow could economically and routinely, serve them. The approach is, at first, to recognize what is being controlled; second, to identify

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[10]Ernst, Martin L., "Computers, Business and Society", Management Review, AMA, V. 59, No. 11, p. 12, November 1970.

potential decisions; and third, to associate a value with the making of each decision as a function of time and information requirements.

Decision time begins in response to new information. It ends with organizational commitment. Normally, the new information is isolated and must be correlated with other information to present a perspective. The correlation process takes time and energy which conflict with the other pending decisions. Decisions are rarely those acts of judgment when line and staff personnel are at the office door waiting to receive direction. Such occasions are usually the result of extended delay in establishing position. More often, a decision involves an evolution from a tentative position, either a stated concern or a conceptual interest. Early recognition enables the management system to function, increasing the certainty of the final commitment. [15]

If the importance of new information could be immediately recognized, an immediate commitment decision would have the least impact upon the available resources. The low impact on resources would give the decision a high value. Typically, a decision must be compared with "research and development". The new information must be investigated so that its potential impact can be understood with a degree of confidence. Early recognition allows review and revision of current, or proposed positions as the management system correlates more information to the decision.

As in research and development, some delay in decisions based upon the information evaluation, must be expected. Decreasing time for implementation imposes a rising level of resource requirements. At some point, the implementation of a decision, within the time constraints, will exceed the available resources. That will severely depress the value of the decision. Further delay will impose increasingly greater demands on resources until it will become questionable whether the decision should be made or replaced. Thus a decision can be seen to have a time of birth and an aging process until a time of death, during which its value will continually diminish in an inverse relationship to its impact on resources. (See Figure 2, Appendix A)

D. THEORY OF VALUE

The value of information is established through its relationship with a decision. New information has a low value because its significance is unknown. Although an early decision is shown to have a high value (Figure 3, Appendix A), uncertainty would cause the decision maker to rely heavily upon assumptions and intuition. Correlation with other information places the new information in perspective. After some point in time, the decision maker ceases his reference to the actual information and shifts to his assumptions. The value of the information recedes. Later, the value increases slightly as the information gains importance for historical purposes

and for trend analysis. Since this is a correlation process, the quantity of information related to a decision varies with the value. The demand grows geometrically until it exceeds the capacity or desires of the decision maker. The human capacity for assimilating quantities of variables is restricted. Unfortunately, technological applications within recent years have enabled the system to deluge the decision maker with quantities of information. This is not to say that the information is used in making the decision. On the contrary, more often, the processed information is rejected in favor of personal confidence or the so-called "gut feeling." The "who" becomes more important than the "what" of the information. This was the trap that was described by Ernst. [16]

Highly successful managers have repeatedly admitted that they consider themselves successful if they are correct in more than 50% of their decisions. Robert Townsend stated that, ". . . my batting average on decisions at Avis was no better than 33%."[11] This must be charged to the information which was used in decision making. The difficulty lies in failure to recognize the nature of the control demands. The actual time restriction on many decisions is unknown. The real need for information is unknown. Therefore,

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[11] Townsend, Robert, Up the Organization, Alfred A. Knopf, p. 115, 1970.

under pressure from assumed time restrictions and in the fear of being deluged with information, many decisions are inordinately based on assumptions and intuition. It is an implied requirement of management that they first manage their personal resources which is their management energy. Next, they manage the organizational resources, which is their stated function. Management is an encounter with uncertainty. No one should be satisfied with a 50% probability of a correct decision, but neither should one expect 100%. Each potential decision should have an established range of acceptable risk as a function of time and the value of information. The commitment decision should be made within this range of acceptable risk. (See Figure 4 Appendix A)

Values vary with the nature of the resources controlled. Time can be in years, or it can be in seconds. The contention with other pending decisions is ever-present, so the actual management time is not the same as the decision time. The immediate presentation of an element of information, sometimes called "real time", has a high cost. First, because of the processing technology to allow immediate information and, second because the decision maker requires it in perspective rather than as a shock. An increase in time until presentation allows less expensive techniques. Information presented in perspective allows more compressed and routine employment of management energy. There are economics of scale. Increasing numbers of elements of information will not require an

equally increasing number of sources. Identification of information values and time requirements for potential decisions in the control of some resource will identify common requirements and minimum time restrictions. Simultaneous capture and parallel transportation will become possible. There are limits. The collection and storage of higher quantities will reach the capacity of the current information systems, beyond which additional management energy, new technologies, or both, will cause an incremental increase in cost. It is the objective of information design to let the system present information in quantities needed, when and where it can be fully appreciated by the decision maker. The optimal system would impose the least total cost by presenting the information when the decision should be made within an acceptable range of risk. (See Figure 5 Appendix A)

E. TIME VERSUS VALUE

The management of information costs must be associated with potential decisions. Each element of information will have its value curve over time, reflecting the time required for its validation. The combined value will develop the value of information curve for the decision. The number of distinct elements must be carefully controlled. A reduction in the number of elements will either reduce cost or time. The information's sensitivity to time could reveal improvement possibilities in value through tightening the update cycle

or in cost, through loosening the cycle. This technique of applying value and cost relationships to information based upon a value of a decision brings the economics of management into focus.

The analysis of decisions within management must be related to the need to make the decision:

1. What is the value of the current decision point in time?
2. What is its sensitivity to time?
3. Does the information, as presented to the decision maker, support the decision and create an acceptable risk?
4. Does the cost of the information exceed the value of the decision?
5. Is there another point in the management structure where the decision could be more economically made, consistent with risk?

Consistently late decisions reduce management's flexibility to allocate, or reallocate resources. This creates a pressure to increase the available resources without a corresponding increase in the market or mission. Figure 6 Appendix A, illustrates the Planning, Programming, and Budgeting System (PPBS) as it might be reflected as a "value of a decision" and impact upon resources.

Planning is generally accepted to be in the five to eight year range, which is beyond the allocation of resources; however, it is the establishment of a position. Programming is generally within the one to five year range where interrelationships are being recognized

and alternatives are being reduced. Budgeting is an allocation process which is followed by commitments. This is an illustration of the "value of a decision" as an evolutionary process over about ten years. Time is relative to the natural cycle of that which is being managed. An air traffic control center might have "planning" based on established schedules. "Programming" might be the processing of flight plans. "Budgeting" however, would probably have a natural cycle in seconds.

F. POSITION FOR THE FUTURE

In the final analysis, an evaluation of management must be based on its impact upon resources. What is being controlled? It is not management if decisions are not being made. It is not a decision unless it involves the allocation or reallocation of resources. Interestingly, the first decision, and one that is repeated throughout, concerns the allocation of the personal resource, management energy.

In the 1960's management committed vast sums of money and time to management information systems without regard for the interpersonal manner in which the functions of management were performed. Decisions were not recognized as evolutionary through natural filtering. Today management information systems are capable of fulfilling demands for information to the detriment of the management who has not faced the "ecological" consideration of his energy. In this decade management must be more concerned

with limiting the quantity of information, through improving the value of lesser amounts. Time must be considered the dominant utility. Time can only be countered through increasing the value of information being presented. It has been recognized that the needed information is available within the information system. If only one could ask the proper questions. The key is to recognize the needs and sources in advance. This acknowledges the importance of an integrated information system. The technique places the information system design alternatives with management rather than with the technician. The identification of decisions can only be accomplished by those who make them. Realistic appraisal of control requirements enables value assignments to management decisions then value assessments for the information needs to support the decision maker.

IV. CONCLUSION

A. TOTAL SYSTEMS APPROACH

A total management information system can best be described as one which produces the many types of information products and services which are required by the system users and contributors. The processing portion of this definition includes the acquisition and communication of data throughout the systems. The information produced by the total MIS would include all of the information required by the manager for his decision making process, i.e., product information, financial information, personnel information, etc..
It is theorized that this Utopian system does not exist at the present time. There does exist however, serious doubt of the feasibility of an organization being able to effectively integrate every information subsystem required for the decision making process into a total MIS. In the case of organizations which have integrated a few of the subsystems, these organizations were highly centralized and had relatively short product lines with limited geographical concentration. Notwithstanding the question of feasibility of achieving a total MIS, it does appear to be highly advisable that the total MIS represents a goal for which system designers should strive. If one accepts the goal or ideal of total integrated systems, he should expect that analysis must get to such a detailed level that common characteristics

can be found which allow meshing of new separated systems. The dramatic analogy is the development of atomic energy. Success was achieved only after theories showed how to identify subdivisions of matter. At some critical subdivision it becomes possible to connect the apparently quite separate elements into a continuous stream of energy. The connection and conversion of energy in business information systems may require even more analytical effort. It appears that success in this field will be more valuable than that achieved in the development of atomic energy. It is especially because of the challenge to handle problems with more rigorous analysis that mathematics will grow in business application.

B. FUTURE

On Tuesday evening, September 9, 1965, the largest power failure in history blacked out all of New York City and some 80,000 square miles of neighboring areas in which nearly 25 million people live and work. The blackout lasted for three hours before partial power was restored. It is awesome today to imagine what the consequences would be if a computer blackout were to occur throughout the world. Yet, in spite of our increasing dependency over the past twenty years on computer technology, one continues to hear of a "technology gap." Instead of a "data famine" the technological issue today is that computers haven't been able to do all that was expected of them. If true, this is a dismal return for a $40 billion investment

in equipment. What went wrong? On one hand, computer manufacturers and the industry have been blamed for overselling, for not developing the proper technology, and for not solving the users problems. On the other hand, the users and managers have been criticized for overbuying hardware, for misapplying an inert technology, for being in the last century, and for not exploiting modern methods. There is some truth on both sides of the arguments.

With respect to the next decade and the correction of past faults it is proposed that the demise of the present day data base orientation as the dominant user model image in MIS development will give rise to a shift back to an output orientation that is user-dependent. The emphasis will be on basic decision processes and problems of the specific organization and manager without regard to the functional environment. Information structures will be developed to solve a particular manager's problems; some of the structures will be generalizable to other situations in broad outline.

The user model image that focuses on critical decision processes for MIS development is only one aspect of the new technology. Allied with the change in orientation will be a rise in the applications of operations research and behavioral science in developing and implementing the information structures. Empirical evidence suggests that:

1. Except for the most routine activities, managers actively resist attempts (real or imagined) to erode their authority base.

2. The executive's orientation is toward the "people" in the organization, and his self concept is as an individual who directs the activities of others.

3. There is relatively little understanding of upper management decision processes.

Emerging information structures in the next ten years will increasingly incorporate behavioral parameters in their design that reflect organizational associations, leadership style, and management attitudes as a means toward improving acceptance and effectiveness at the user/system interface.

In conclusion, even with such technological breakthroughs such as increased equipment capability and automatic file indexing, management information systems will become progressively complex as computer applications are extended to cover wider areas of interest to management in the quest for the goal of a total MIS. It is not difficult to perceive in the near future that management information systems efficiently designed will provide not only factual data but also statistical extrapolations, decision functions, and even the calculated risks associated with alternative courses of action. It is also anticipated that significant breakthrough will occur in the area of generalized data base management systems. Eventually, when the necessary technological advances have occurred, the system designer will be able to develop a total computer based management information system.

RANGE OF PREDICTED
MANAGEMENT STRUCTURES

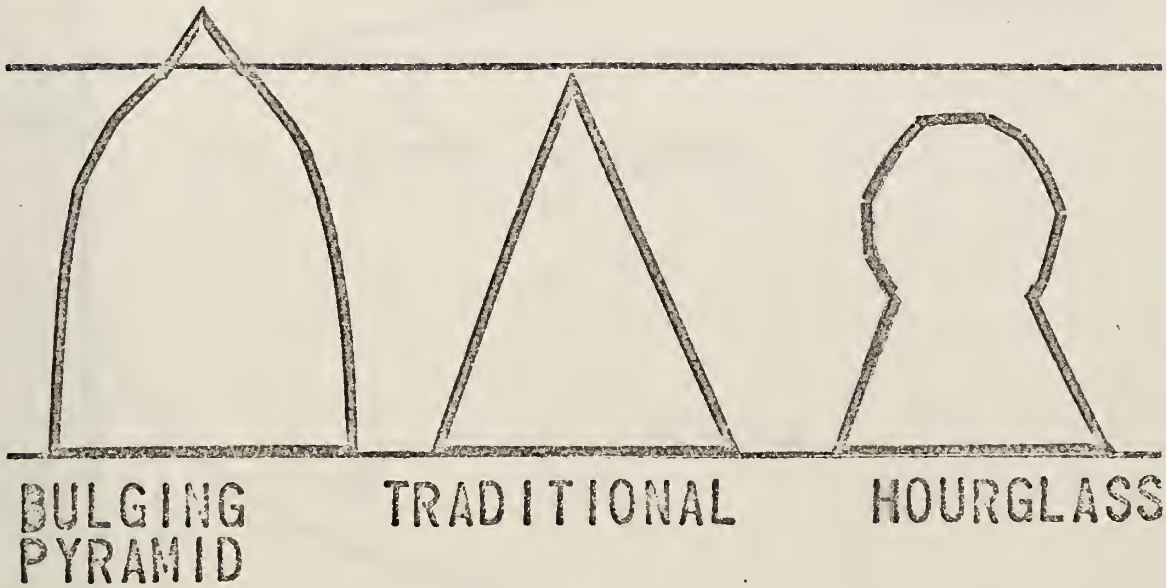
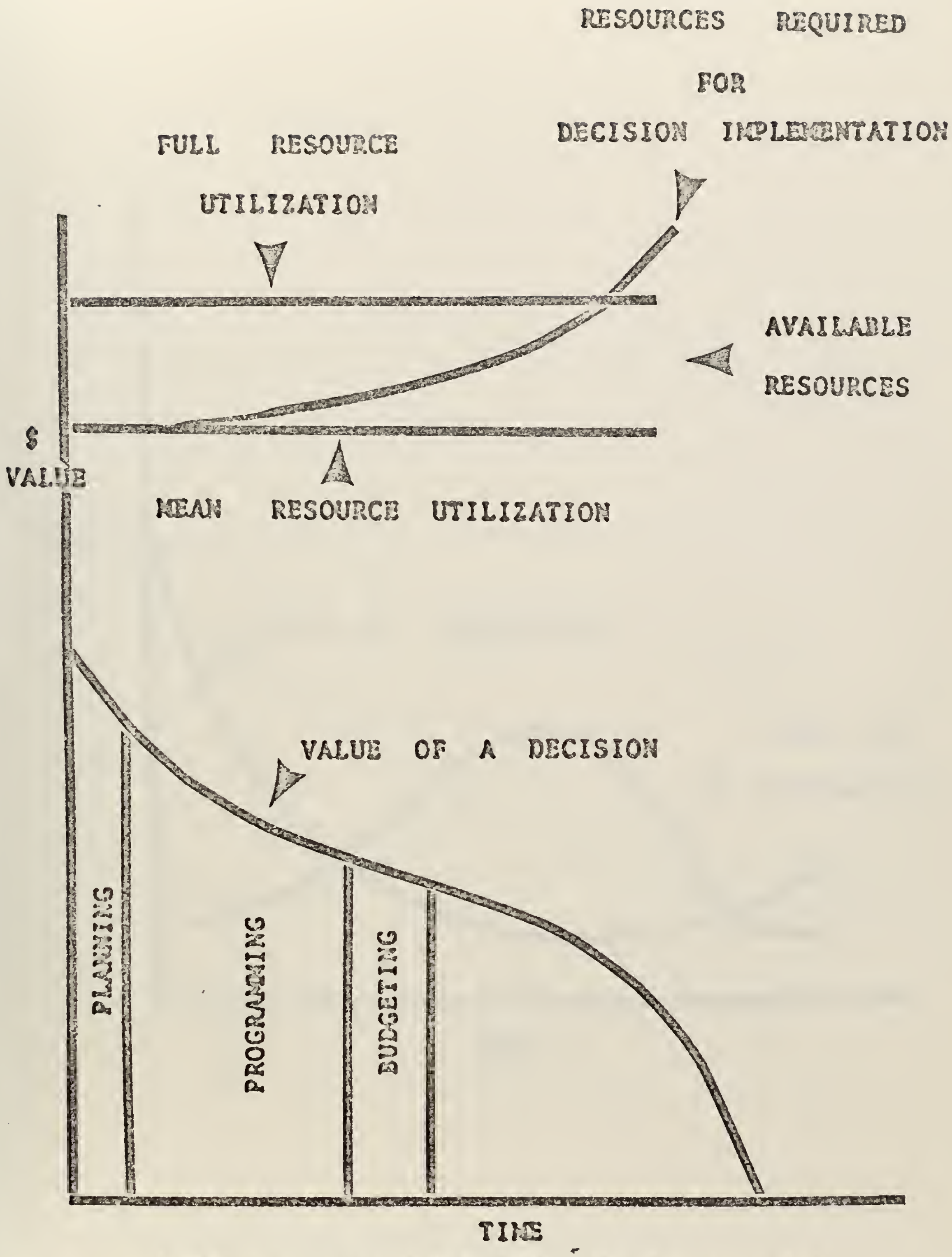
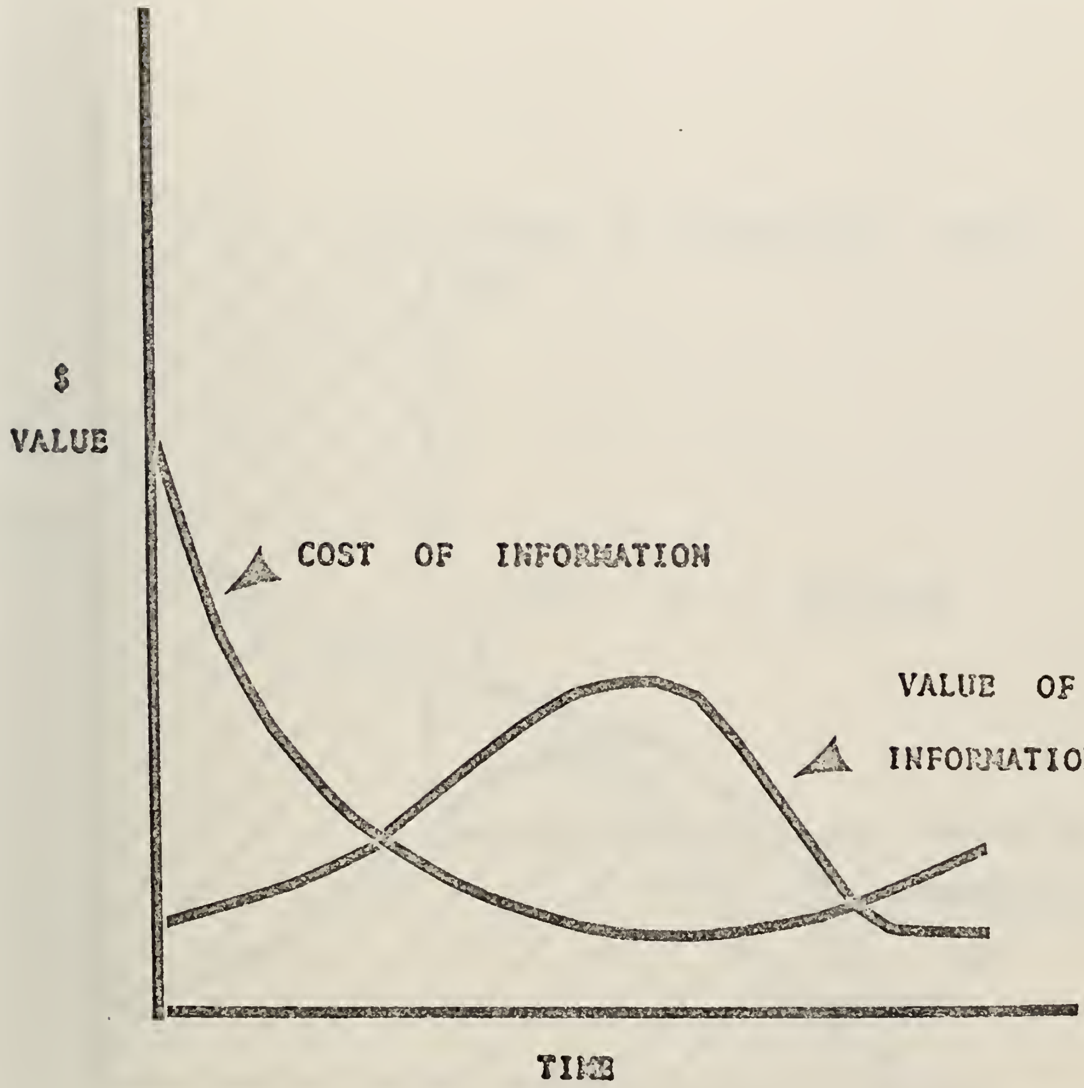


FIGURE I



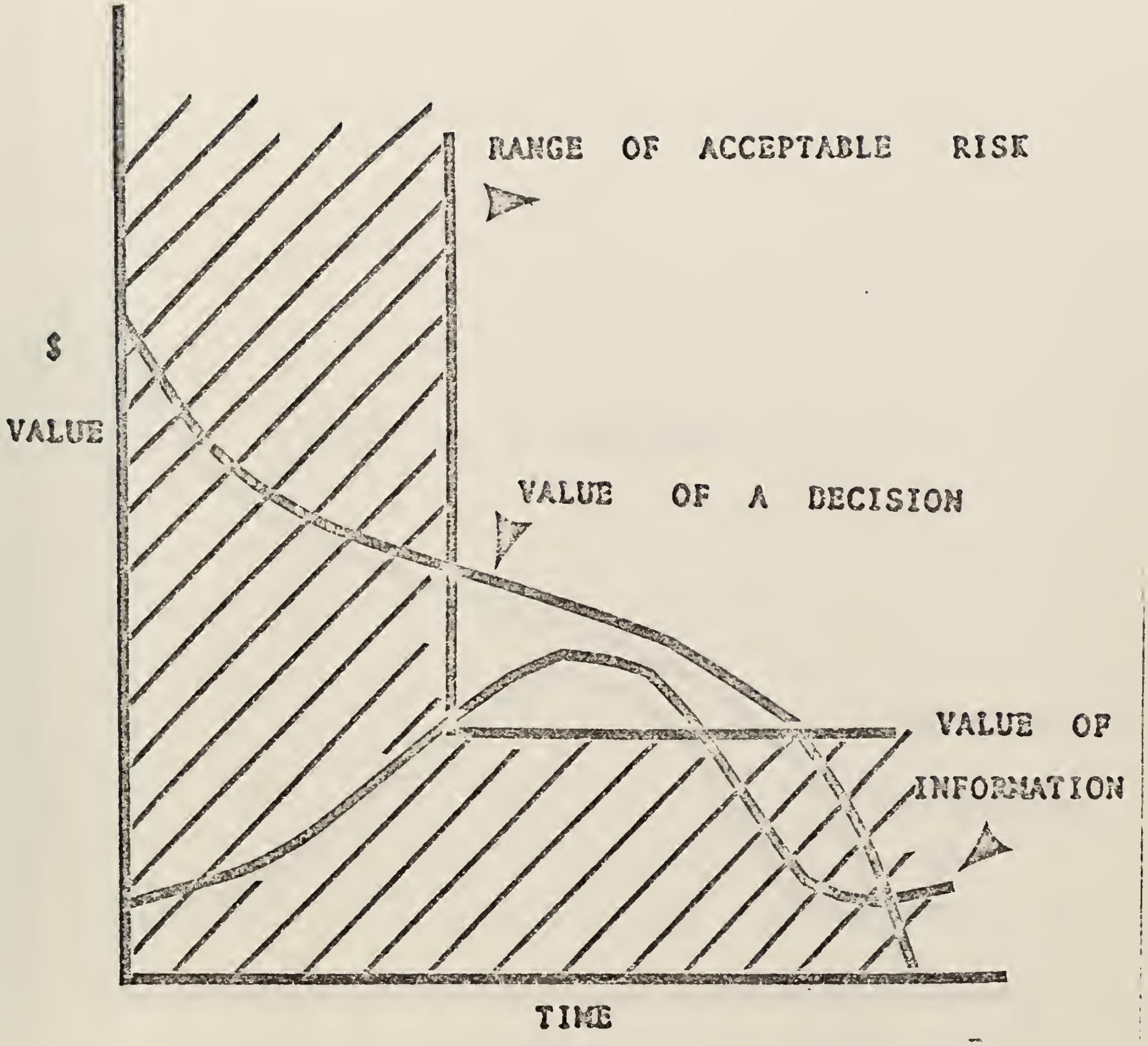
PPBS- IMPACT ON RESOURCES

FIGURE 6



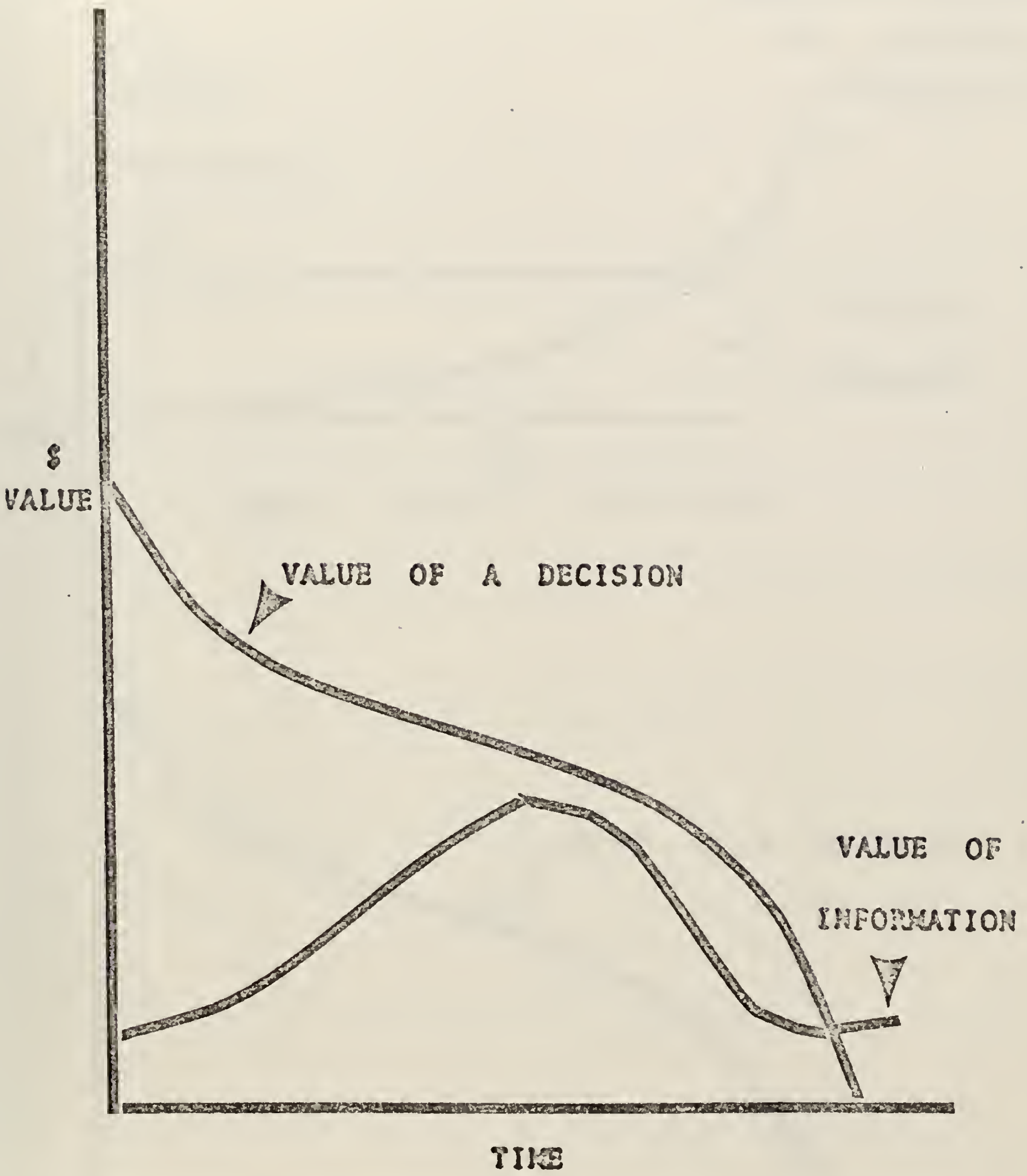
OPTIMIZING COST

FIGURE 5



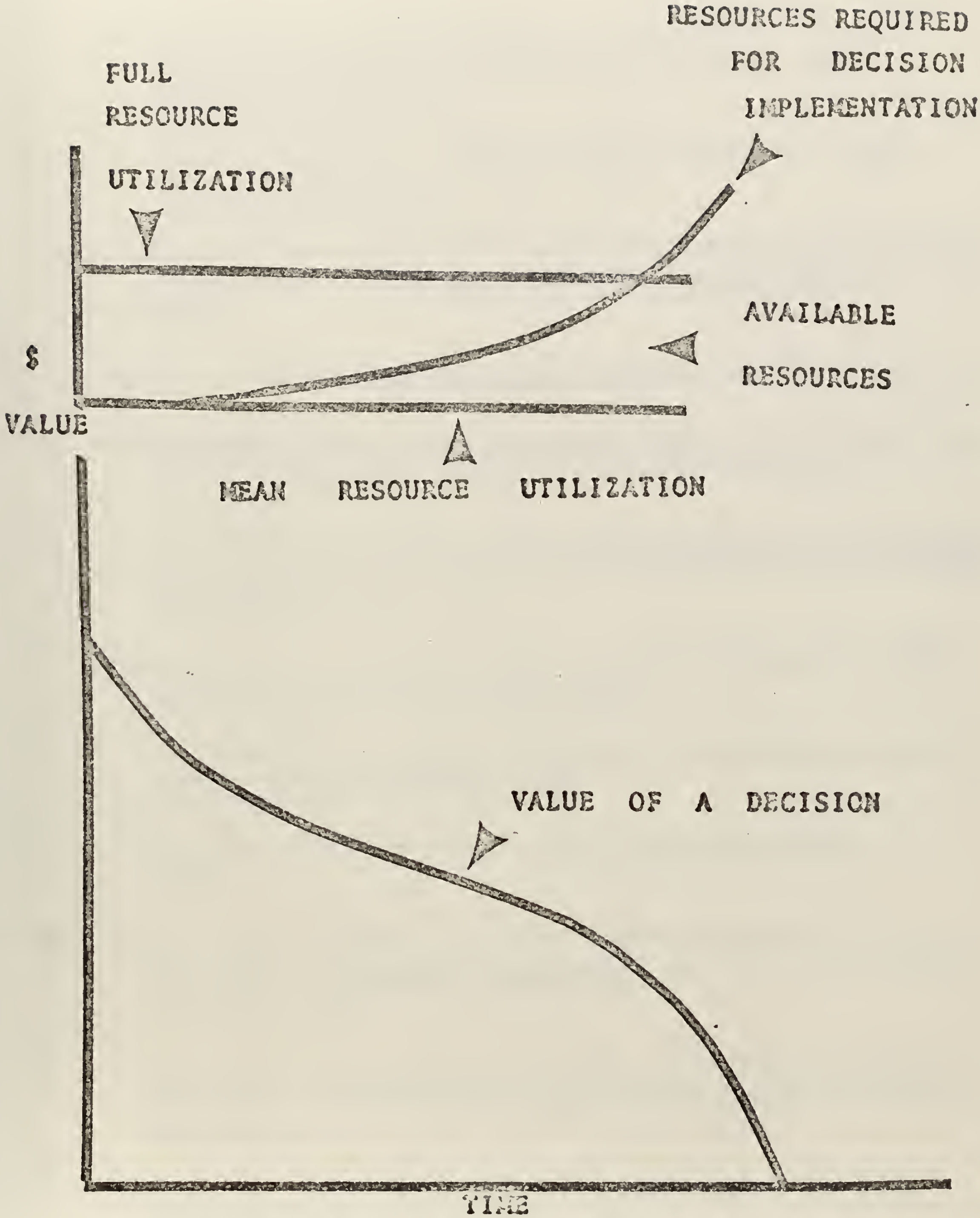
VALUE VS RISK

FIGURE 4



QUANTITY VS VALUE OF INFORMATION

FIGURE 3



LIFE CYCLE OF A DECISION

FIGURE 2

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ABSTRACT

Management information is of critical importance in modern decision making. The role of the computer in this process is rapidly expanding, creating challenging goals for data processing specialists and functional area specialists alike. A totally integrated computer based management information system requires long term planning and design effort coupled with detailed analysis of information system requirements. This paper suggests a new relationship between the time value of information and management decision making.

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Decision Making						
Information Value						
Computer System						

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